Difference Tester User Guide Version 1.0.00 — Difference Tester: Totals

https://apps.fs.usda.gov/Evalidator/diftester.jsp

Difference Tester: Ratios

https://apps.fs.usda.gov/Evalidator/diftesterratio.jsp

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October 16, 2019

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Introduction

The Forest Inventory and Analysis (FIA) program (https://www.fia.fs.fed.us/) of the U.S. Forest Service inventories and assesses the Nation's forest resources and publishes the data and findings to the public. Online analytical tools from FIA (https://www.fia.fs.fed.us/tools-data/) provide current inventory and change estimates that guide management and policy decisions on our Nation's forest resources. A broad range of temporal comparisons are of interest to analysts. For example, an increase in the number of standing dead trees can indicate a forest health issue.

Often, these comparisons have covariance because the estimates are derived from observations on the same plots over time (not independent). Specifically, the lack of independence requires that a covariance term be accounted for when computing the standard error of the difference between two attributes (Husch et al. 1982). Covariance should be accounted for when conducting hypothesis testing for statistically significant differences (Westfall et al. 2013). However, in many cases, the only knowledge at hand for each attribute is the estimate and associated standard error. Failure to include covariance in statistical tests can foster incorrect conclusions and poor management decisions.

The Difference Tester (Difference Tester: Totals version at https://apps.fs.usda.gov/Evalidator/diftester.jsp and Difference Tester: Ratios version at https://apps.fs.usda.gov/Evalidator/diftesterratio.jsp) accounts for covariance when comparing total and per acre estimates of a chosen attribute over time. A calculated z-score and p-value indicate the likelihood that a difference is different from 0 (no difference).

A user must have knowledge of the FIA inventory (Bechtold and Patterson 2005), FIA database (Burrill et al. 2018; database available at https://apps.fs.usda.gov/fia/datamart/CSV/datamart_csv.html), Structured Query Language (SQL) (Pugh et al. 2018) and statistics to effectively use Difference Tester.

The SQL calculations that generate statistics for the totals version and ratios version are contained in the REF_DIFFERENCE_TEST_TOTALS and REF_DIFFERENCE_TEST_PER_ACRE tables of the FIA Database, respectively.

FIA inventory

Sampling in the FIA program consists of a network of randomly located plots (fixed positions) where standard forest inventory measurements are collected throughout the United States (Bechtold and Patterson 2005). There is a minimum of one plot for approximately every 6,000 acres of forest land. Each plot consists of four fixed-radius subplots covering approximately 1/6th of an acre.

Many condition attributes (e.g., forest type, stand size, and age) and tree-level attributes (e.g., species, diameter, and height) are measured in these plots. From these measurements, estimates for many other attributes are available (e.g., volume, mortality, removals, and net growth).

Prior to 1999, all FIA inventories in the United States were conducted on a periodic basis, every 10 to 15 years. With the passage of the 1998 Farm Bill, FIA collects data annually on a portion of plots within each state so that up-to-date information essential to framing realistic forest policies and programs is available.

Under the annual inventory system, a percentage of the sample plots are measured each year. The percentage has varied among regions and over time within regions (generally from 10 to 20 percent). The set of plots measured within a single year is referred to as a panel (Fig. 1). Once all plots have been measured, they are placed into a group, representing the most recent measurement of each plot. In general for the eastern United States, the sample was 20 percent per year until it changed to 14.3

percent in 2014. Fig. 1 represents a five panel design (20 percent per year) implemented over 5-year inventory cycles. In this case, years 1-5 are grouped initially, then years 2-6, 3-7, and so on. This creates a moving timeline of data for analytical purposes. Also, the grouping of years 1-5 is considered the first inventory cycle, years 6-10 is the second cycle, and so on (Fig. 1).

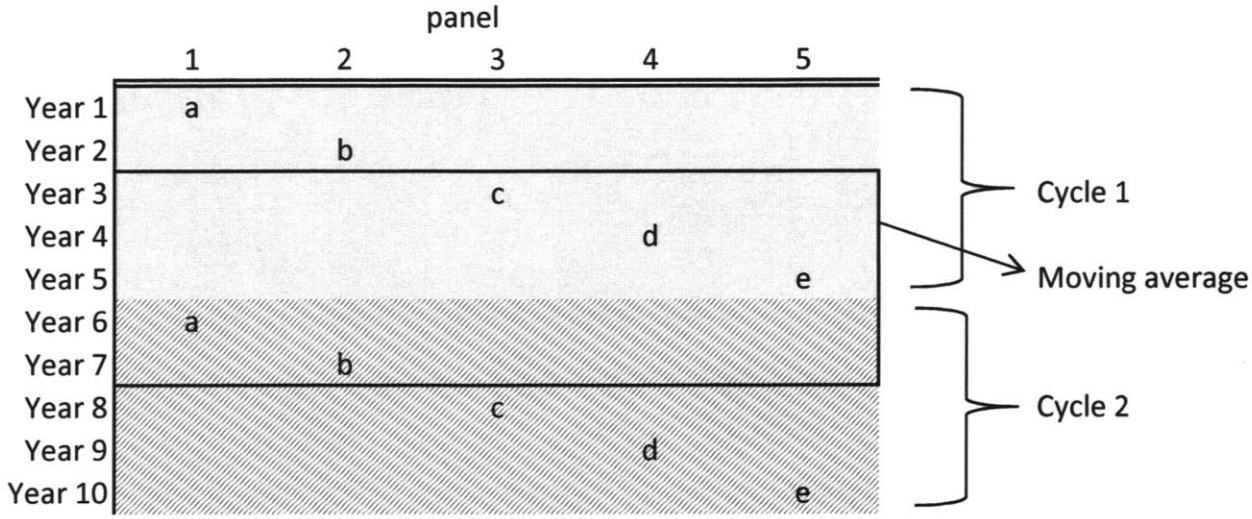


Figure 1.—Schematic of a five panel design implemented over 5-year inventory cycles. Each letter (a, b, c, d, and e) represents a separate panel (Westfall et al. 2013).

The last year of each cycle is used to name the full set of plots. For example, a 5-year cycle of plots measured from 2004 through 2009 are collectively labeled the "2009 inventory". In another example, the Michigan 2017 inventory includes plots measured in 2011 through 2017. The eastern United States switched to a 7-year inventory cycle in 2014.

Currently in FIA, sample sets of change are only identified between consecutive plot visits. Hence, estimates of change with associated sampling errors are only available between consecutive plots visits. Using a 5-year cycle of plots as in Fig. 1, change in tree volume is the difference observed from plot measurements in years 6 - 10 and measurements from the same plots in years 1-5. The change is reported as the change for the "year 10 inventory." In another example, change for the Michigan 2017 inventory includes plots sampled in 2006 - 2011 and then resampled five to six years later in 2011 - 2017.

In the Michigan example, the measurements from 2011-2017 are collectively identified as the time 2 measurements and the measurements from 2006-2011 are collectively identified as the time 1 measurements. These time 1 and time 2 plot measurements are collectively identified as a change evaluation. An evaluation is a full sample set of plots for which a particular set of population estimates and sampling errors can be calculated. In addition to the change evaluation, there are other evaluations for estimating attributes such as current volumes, current areas, and current forest health indicators such as invasive plant species coverage and down woody materials biomass. Each evaluation usually has a different set of plots for a given cycle. Change evaluations usually have fewer plots than current evaluations for analogous attributes because it is more likely that a plot is not sampled two consecutive times (time 1 and time 2) versus being sampled just in time 2. An evaluation group collectively identifies all the available evaluations for a given cycle. The evaluation group code includes the State FIPS code

(Federal Information Processing Standards [FIPS]) as the first two digits and the last year of the cycle in question for the last four digits. The evaluation group the MI 2017 inventory is 262017.

Working with Difference Tester

Comparison Attribute

The **Comparison Attribute** list box appears at the top of the Difference Tester interface. It has the attributes available for comparison (e.g., number of live trees). Only one comparison attribute can be chosen per comparison.

Evaluation Group

The **Evaluation Group** list box has the evaluation group choices. For example, the evaluation group for the Michigan 2017 inventory is "262017 MICHIGAN 2017: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION". Based upon the chosen comparison attribute, Difference Tester uses the appropriate change evaluation from the selected evaluation group or groups. Choosing "262017 MICHIGAN 2017 …" will result in the difference estimate between the time 2 and time 1 measurements of the MI 2017 inventory. Difference Tester only calculates estimates of change during the FIA annual inventory, so evaluation groups will be from the early 2000s onward.

Comparisons can be made for a single or multiple evaluation groups. To add or subtract to the list of selected evaluation groups, hold down the CTRL key while clicking on the items. When multiple evaluation groups are selected, output is collective for all specified. For example, selecting a Michigan and a Wisconsin evaluation group compares estimates for the chosen attribute of Michigan and Wisconsin combined (e.g., total number of live trees for MI and WI). Selecting more than one evaluation group for a given state returns invalid results. For example, selecting evaluation groups 262017 and 262011 will provide invalid results. When selecting multiple state evaluation groups, normally choose evaluation groups of the same inventory year (e.g., Michigan 2017 and Wisconsin 2017) to reflect the same general economic and climatic conditions for each state.

Filters:

Except for one comparison (-- Area of sampled land and water, in acres), the comparisons are constrained to forest land as the comparison attribute descriptions indicate. For example, "Number of live trees (at least 1 inch d.b.h./d.r.c) in trees, on forest land" is constrained to forest land, regardless of what is entered in any filter text box (see Appendix 1). Additional criteria or constraints are defined by specifying SQL in the filter text boxes. See Burrill et al. 2018 for information on table columns and Pugh et al. 2018 for SQL examples using filters. See Examples for specific filter examples.

In the totals version of Difference Tester, use **Filter for time 2 (constraint_y_time2)** and **Filter for time 1 (constraint_y_time1)** to further constrain the population of interest. For time 2, use "p", "c" and "t" to specify the plot, condition (name is cond in FIA Database), and tree tables, respectively. For time 1, use "p1", "c1" and "t1" to specify the plot, condition, and tree tables, respectively. Tree tables are not valid for area comparisons.

There are many possible constraints. For example, one can compare estimates of forest land for National Forest ownership between time 2 and time 1. Use "and c.owncd = 11" in the filter box for time 2 and "and c1.owncd=11" in the filter box for time 1.

In the ratio version of Difference Tester, specify time 2 constraints in **Filter for time 2 numerator (numerator_constraint_y_time2)** and **Filter for time 2 denominator**

(denominator_constraint_x_time2). Specify time 1 constraints in **Filter for time 1 numerator (numerator_constraint_y_time1)** and **Filter for time 1 denominator (denominator_constraint_x_time1)**.

As in the totals version, use "p", "c" and "t" to specify the plot, condition, and tree tables, respectively, for time 2. For time 1, use "p1", "c1" and "t1" to specify the plot, condition, and tree tables, respectively. In the ratios version, there are no area attributes available in the **Comparison Attribute** list box and tree tables are not valid in the denominator filters for per acre estimates. In the current version, it is not possible to compare ratios with tree volume estimates in the denominator. This version only compares tree attribute values per acre. In the future, other types of ratio comparisons may be added.

Continue

Selecting **Continue** runs Difference Tester and produces an output Web page with statistics and metadata on the comparison (see Appendix 2 and Appendix 3). Output statistics specific to time 1 and time 2 are labeled with "TIME1" or "T1" and "TIME2" or "T2", respectively. For the totals version, the estimates (ESTIMATE_X_TIME2 and ESTIMATE_Y_TIME1), the difference (DIFFERENCE_X_Y) and the p-value (P_VALUE_TWO_TAILED_TEST) are of most interest. Likewise, the ratio estimates (RATIO_Y_X_TIME2 and RATIO_YPRIME_XPRIME_TIME1), the difference (DIFFERENCE_RATIOS) and the p-value (P_VALUE_TWO_TAILED_TEST) are the output variables of most interest in ratios version. See Appendix 1 and Examples for information on interpreting the output.

The output Web page has a link, **Identify the inventory years for time 1 and time 2,** that will identify the time 1 and time 2 sample inventory years among plots for the chosen evaluation group. The link employs EVALIDator (http://apps.fs.fed.us/Evalidator/evalidator.jsp) for this task. A **RESTful Web Service Call** is also available to generate the output directly from a browser address line. This can be saved and passed into a Web browser at a later time to run the comparison again. There is a Web citation for Difference Tester and a reference on conducting tests for statistically significant differences (Westfall et al. 2013).

Examples

Difference Tester: Totals

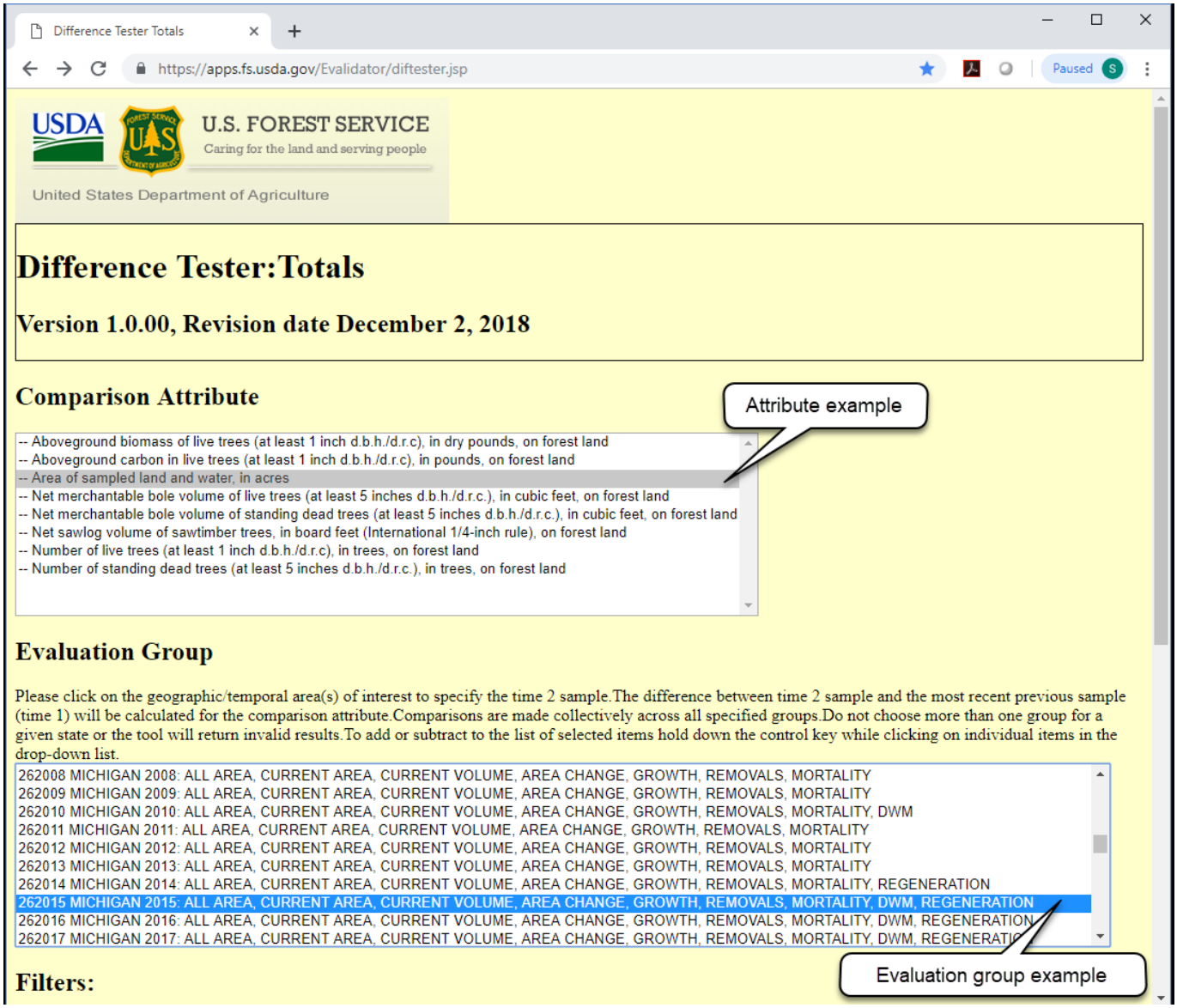
Screen shots of Difference Tester: Totals with specified input and resulting output are provided for the first example. Subsequent examples list the required input and show selected output without screen shots.

Examples for Comparison Attribute -- Area of sampled land and water, in acres

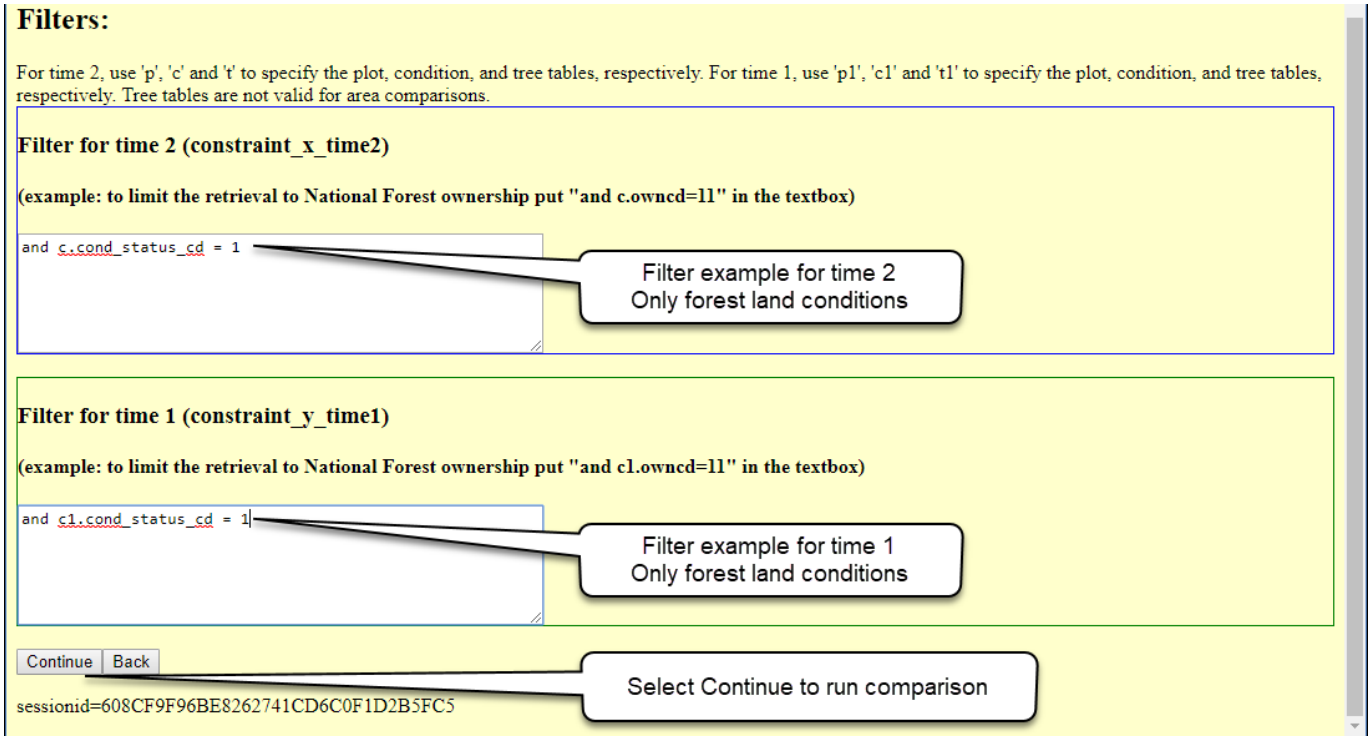
Example 1
Compare forest land (c.cond_status_cd = 1) over time (use link **Identify the inventory years for time 1 and time 2** on the output page to identify the specific sample years) for Michigan 2015.

<u>Input</u>
Comparison Attribute:
-- Area of sampled land and water, in acres

Evaluation Group:
262015 MICHIGAN 2015: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION



Filter for time 2 (constraint_x_time2):
and c.cond_status_cd = 1
Filter for time 1 (constraint_y_time1):
and c1.cond_status_cd = 1



<u>Output</u>
DIFFERENCE_X_Y: 179,781
P_VALUE_TWO_TAILED_TEST: 0.0005

EVALIDator Version 1.8.0.00

https://apps.fs.usda.gov/Evalidator/diftesterPost.jsp

Difference tester for totals

CREATED_DATE	2019-03-11 11:00:21.0
SCHEMA	FS_FIADB
COMPARISON	-- Area of sampled land and water, in acres (-- 0079)
ACROSS_EVAL_GROUPS	262015
CONSTRAINT_X_TIME2	and c.cond_status_cd = 1
CONSTRAINT_Y_TIME1	and c1.cond_status_cd = 1
ESTIMATE_X_TIME2	20,198,855.7461
ESTIMATE_Y_TIME1	20,019,074.2823
DIFFERENCE_X_Y	179,781.4640
DIFFERENCE_TEST	P-value is less than critical value of 3 standard errors associated with 99% confidence level
STD_ERROR_DIFFERENCE	51,699.2209
Z_SCORE	3.4775
P_VALUE_TWO_TAILED_TEST	0.0005
NON_ZERO_PLOTS_X_TIME2	3805
NON_ZERO_PLOTS_Y_TIME1	3738
VARIANCE_X_TIME2	13,628,187,757.9067
VARIANCE_Y_TIME1	13,657,090,627.6798
COVARIANCE_XY_FINAL	12,306,234,473.2292
COV_CORRECTION	1
TOTAL_PLOTS	6094
TOTAL_POPULATION_ACRES	37,385,326.5000

Comparing sampled area between time 1 and time 2

MI 2015 inventory

Filtered to forest land at time 1 and time 2

Forest land difference from time 1 to time 2 for the MI 2015 inventory

p-value is less than 0.0099 (3 standard errors) indicating a significant difference at 99% confidence level

Value of 1 indicates covariance among all sample sets. Values less than 1 indicate partial covariance

Identify the inventory years for time 1 and time 2

Select to show area and number of plots by time 1 (previous inventory years) and time 2 (current inventory years) for the change sample of the MI 2015 inventory

RESTful Web Service Call

This RESTful Web Service call can be used to generate estimates directly from browser address line
https://apps.fs.usda.gov/Evalidator/rest/Evalidator/diftestTotal?comparison_type=-- temporal_area_total&attribute_nbr=--0079&schema=FS_FIADB&eval_grp_as_stateyear=262015&constraint_x_time2=and c.cond_status_cd = 1&constraint_y_time1=and c1.cond_status_cd = 1

Web citation: Pugh, S.A.; Westfall, J.A. Mon Mar 11 16:00:24 GMT 2019. Difference Tester Total web-application Version 1.0.0 St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. [Available only on internet: https://apps.fs.usda.gov/Evalidator/rest/Evalidator/diftestTotal?]

Reference: Westfall, James A.; Pugh, Scott A.; Coulston, John W. 2013. Conducting tests for statistically significant differences using forest inventory data. Res. Pap. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 10 p.?https://doi.org/10.2737/NRS-RP-22.

Partial output from choosing "Identify the inventory years for time 1 and time 2"

Numerator attribute number and description: 0126 Area change - sampled at both inventories by remeasured plots FIADEF as the forest land definition.
Statecd/EVALID(s):
Michigan 262015
Page variable=None (based on values from the Current inventory).
Row variable=Inventory year (based on values from the Previous inventory). — Time 1
Column variable=Inventory year (based on values from the Current inventory). — Time 2
Filtering clause(s):
... — Output removed from this example for brevity

Number of non-zero plots in estimate:

Note: total number of plots in selected evaluations=6094

	Inventory year						
Inventory year	**Total**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**
Total	6,093	902	797	1,033	1,290	1,306	765
2010	560	560	-	-	-	-	-
2009	1,139	342	797	-	-	-	-
2008	1,033	-	-	1,033	-	-	-
2007	1,290	-	-	-	1,290	-	-
2006	1,306	-	-	-	-	1,306	-
2005	765	-	-	-	-	-	765

Example 2.
Compare forest land acreage over time for Connecticut 2015, Massachusetts 2014, and Rhode Island 2014 collectively.

<u>Input</u>
Comparison Attribute:
-- Area of sampled land and water, in acres

Evaluation Group:
092015 CONNECTICUT 2015: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION
252014 MASSACHUSETTS 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION
442014 RHODE ISLAND 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c.cond_status_cd = 1
Filter for time 1 (constraint_y_time1):
and c1.cond_status_cd = 1

Output
DIFFERENCE_X_Y: 79,851
P_VALUE_TWO_TAILED_TEST: 0.0083

Example 3
Compare forest land acreage over time for black ash/American elm/red maple and sugarberry/hackberry/elm/green ash forest types (c.fortypcd) in the southern Lower Peninsula (c.unitcd) of MI 2015.

Input
Comparison Attribute:
-- Area of sampled land and water, in acres

Evaluation Group:
262015 MICHIGAN 2015: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c.fortypcd in (701,706) and c.unitcd = 4
Filter for time 1 (constraint_y_time1):
and c1.fortypcd in (701,706) and c1.unitcd = 4

Output
DIFFERENCE_X_Y: -146,605
P_VALUE_TWO_TAILED_TEST: 0.0005

Example 4
This example does not follow the previous examples. It compares the acreages of two different types of diversion (c.presnfcd), forest to agriculture and forest to developed, in MI 2015. Is the diversion acreage of forest to agriculture different from the acreage of forest to developed? In this case, the parameters are not adhering to the time 1 and 2 pattern. Each input parameter represents a type of diversion. This example uses the NRS present nonforest land use change field. -- Area of sampled land and water, in acres is the only attribute where one can specify time 1 and time 2 constraints in either time 1 or time 2 filter text boxes.

Input
Comparison Attribute:
-- Area of sampled land and water, in acres

Evaluation Group:
262015 MICHIGAN 2015: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c1.cond_status_cd = 1 and c.presnfcd in (10,11,12,13,14,15,16,17)
Filter for time 1 (constraint_y_time1):
and c1.cond_status_cd = 1 and c.presnfcd in (30,31,32,33,34)

Output
DIFFERENCE_X_Y: -52,781

P_VALUE_TWO_TAILED_TEST: 0.0264

Examples for Comparison Attribute -- Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees, on forest land

Example 1
Compare total number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land over time in Michigan 2014. The tool inherently constrains the query to live trees at least 1 inch d.b.h. on forest land so the filter text boxes can be left blank. Forest land can be specified in the constraints but this will not affect results.

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land

Evaluation Group:
262014 MICHIGAN 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
Filter for time 1 (constraint_y_time1):

Output
DIFFERENCE_X_Y: 280,711,574
P_VALUE_TWO_TAILED_TEST: 0.0048

Example 2
Compare total number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land over time in Michigan 2014. This is the same as example 1 but shows that passing in constraints requiring forest land results in same answer.

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land

Evaluation Group:
262014 MICHIGAN 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c.cond_status_cd = 1
Filter for time 1 (constraint_y_time1):
and c1.cond_status_cd = 1

Output
Difference_x_y: 280,711,574
P_VALUE_TWO_TAILED_TEST: 0.0048

Example 3

Compare total number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on timberland over time in Michigan 2014. The tool inherently constrains the query to forest land, according to the description, but extra constraints for timberland are required. Timberland is not reserved (c.reservcd = 0) and productive (c.siteclcd in [1,2,3,4,5,6]) forest land (c.cond_status_cd = 1).

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land

Evaluation Group:
262014 MICHIGAN 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c.reservcd = 0 and c.siteclcd in (1, 2, 3, 4, 5, 6)
Filter for time 1 (constraint_y_time1):
and c1.reservcd = 0 and c1.siteclcd in (1, 2, 3, 4, 5, 6)

Output
DIFFERENCE_X_Y: 244,881,425
P_VALUE_TWO_TAILED_TEST: 0.0128

Example 4
Compare total number of live ash (t.spcd) trees (at least 5 inches d.b.h.) on forest land over time in Ohio 2014.

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land

Evaluation Group:
392014 OHIO 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and t.spcd in (540,541,543,544,546) and t.dia >= 5
Filter for time 1 (constraint_y_time1):
and t1.spcd in (540,541,543,544,546) and t1.dia >= 5

Output
DIFFERENCE_X_Y: -7,470,246
P_VALUE_TWO_TAILED_TEST: 0.0004

Example 5
Compare total number of cull (t.treeclcd) American beech trees (at least 5 inches d.b.h.) on private (c.owncd) forest land over time in the eastern Upper Peninsula inventory unit (c.unitcd) of MI 2015.

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c), in trees, on forest land

Evaluation Group:

262015 MICHIGAN 2015: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION
Filter for time 2 (constraint_x_time2):
and t.spcd =531 and t.dia >= 5 and t.treeclcd in (3,4) and c.unitcd = 1 and c.owncd = 46
Filter for time 1 (constraint_y_time1):
and t1.spcd =531 and t1.dia >= 5 and t1.treeclcd in (3,4) and c1.unitcd = 1 and c1.owncd = 46

Output
DIFFERENCE_X_Y: 1,320,335
P_VALUE_TWO_TAILED_TEST: 0.0394

Examples for Comparison Attribute -- Number of standing dead trees (at least 5 inches d.b.h./d.r.c.), in trees, on forest land

Example 1
Compare total number of standing dead ash trees (at least 5 inches d.b.h.) on forest land within ½ mile from improved roads (p.rddistcd) over time in Michigan 2014. Note p-value is less than critical value of 3 standard errors associated with 99% confidence level. Compare to nonsignificant result in example 2.

Input
Comparison Attribute:
-- Number of standing dead trees (at least 5 inches d.b.h./d.r.c.), in trees, on forest land

Evaluation Group:
262014 MICHIGAN 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and t.spcd in (540,541,543,544,546) and p.rddistcd in (1,2,3,4,5)
Filter for time 1 (constraint_y_time1):
and t1.spcd in (540,541,543,544,546) and p1.rddistcd in (1,2,3,4,5)

Output
DIFFERENCE_X_Y: 24,591,338
P_VALUE_TWO_TAILED_TEST: <0.000066

Example 2
Compare total number of standing dead ash trees (at least 5 inches d.b.h.) on forest land greater than 5 miles from improved roads (p.rddistcd) over time in Michigan 2014. Note p-value is less than critical value of 1 standard error associated with 68% confidence level. Compare to significant result in example 1.

Input
Comparison Attribute:
-- Number of standing dead trees (at least 5 inches d.b.h./d.r.c.), in trees, on forest land

Evaluation Group:
262014 MICHIGAN 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and t.spcd in (540,541,543,544,546) and p.rddistcd = 9
Filter for time 1 (constraint_y_time1):
and t1.spcd in (540,541,543,544,546) and p1.rddistcd = 9

Output
DIFFERENCE_X_Y: -73,854
P_VALUE_TWO_TAILED_TEST: 0.1471

Examples for Comparison Attribute -- Net merchantable bole volume of live trees (at least 5 inches d.b.h./d.r.c.), in cubic feet, on forest land

Example 1
Compare total net volume of live trees (at least 5 inches d.b.h.) on forest land over time in Maine 2014. The tool inherently constrains the query to live trees (at least 5 inches d.b.h.) on forest land so the filter text boxes can be left blank. Optionally, forest land can be specified in the constraints but this will not affect results.

Input
Comparison Attribute:
-- Net merchantable bole volume of live trees (at least 5 inches d.b.h./d.r.c.), in cubic feet, on forest land

Evaluation Group:
232014 MAINE 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
Filter for time 1 (constraint_y_time1):

Output
DIFFERENCE_X_Y: 1,017,342,570
P_VALUE_TWO_TAILED_TEST: < 0.000066

Example 2
Compare total net volume of growing-stock trees over time on Maine 2014 private forest land for white spruce and black spruce.

Input
Comparison Attribute:
-- Net merchantable bole volume of live trees (at least 5 inches d.b.h./d.r.c.), in cubic feet, on forest land

Evaluation Group:
232014 MAINE 2014: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 (constraint_x_time2):
and c.owncd in (46) and t.spcd in (94,95) and t.treeclcd = 2
Filter for time 1 (constraint_y_time1):
and c1.owncd in (46) and t1.spcd in (94,95) and t1.treeclcd = 2

Output
DIFFERENCE_X_Y: 45,485,192
P_VALUE_TWO_TAILED_TEST: 0.0688

Difference Tester: Ratios

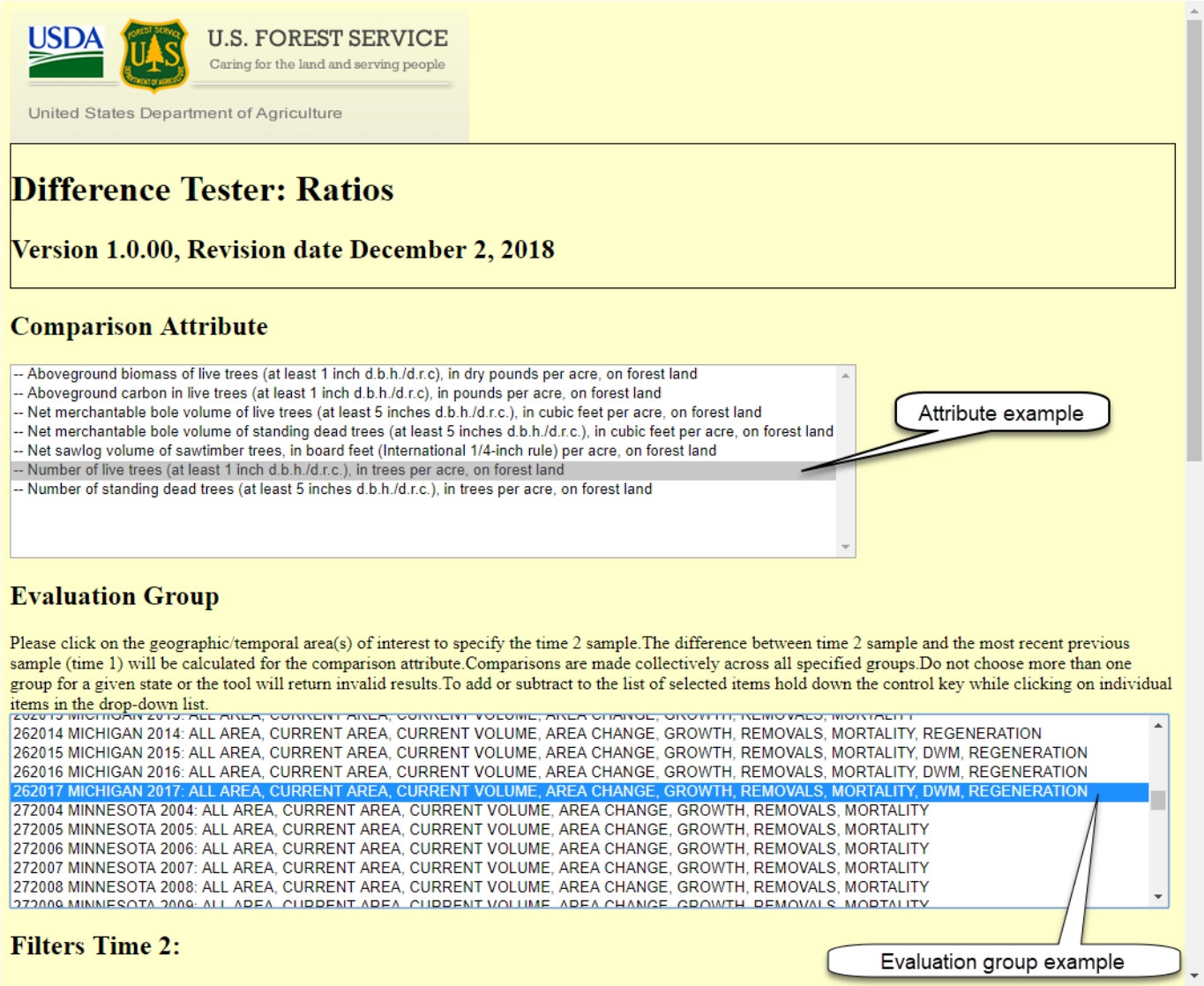
Screen shots of Difference Tester: Ratios with specified input and resulting output are provided for the first example. Subsequent examples list the required input and show selected output without screen shots.

Examples for Comparison Attribute -- Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees per acre, on forest land

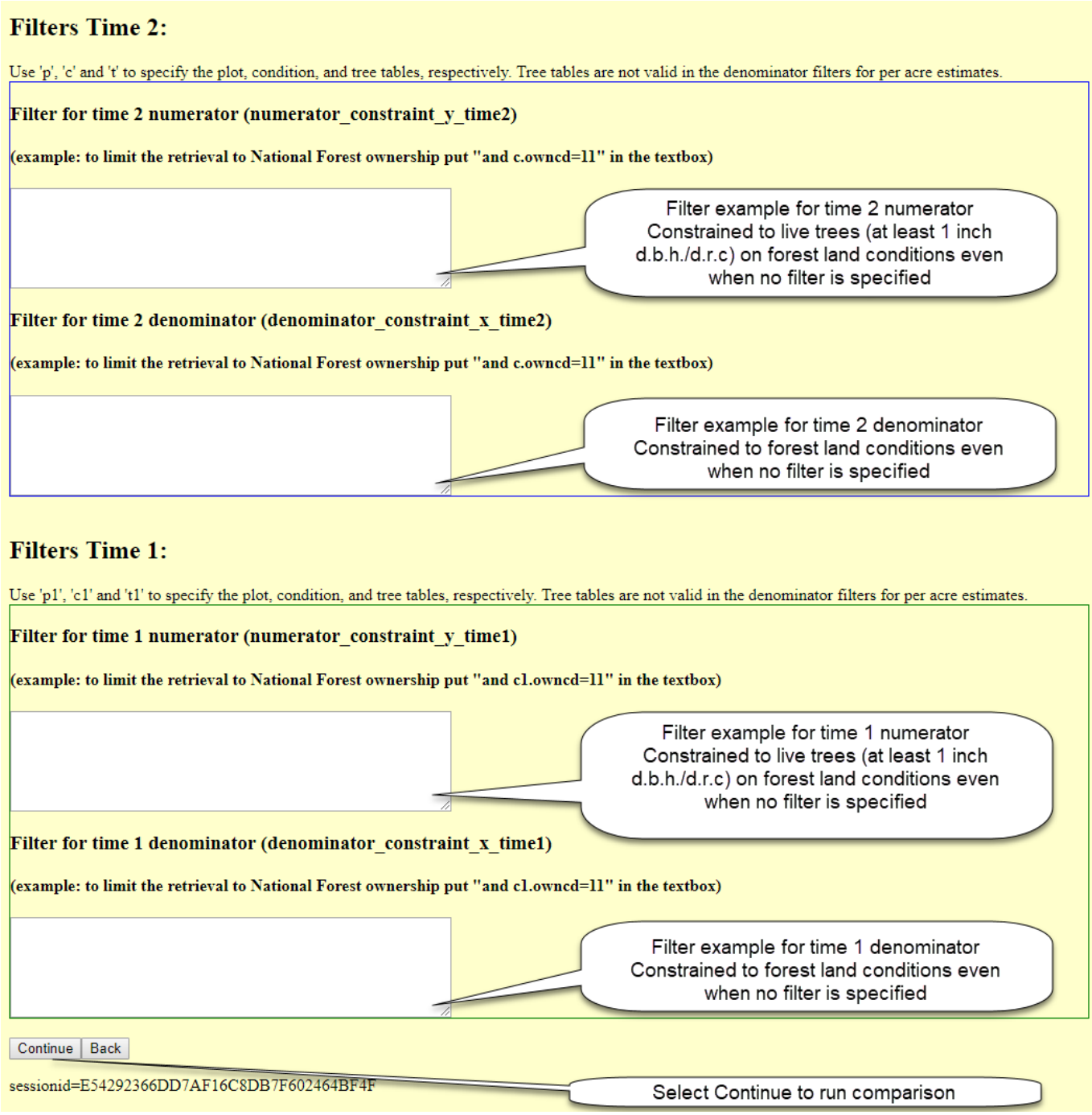
Example 1
Compare number of live trees (at least 1 inch d.b.h./d.r.c), in trees per acre, on forest land over time in Michigan 2017. The tool inherently constrains the query to live trees at least 1 inch d.b.h./d.r.c on forest land, according to the description, so the filter text boxes can be null.

Input
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees per acre, on forest land

Evaluation Group:
262017 MICHIGAN 2017: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION



Filter for time 2 numerator (numerator_constraint_y_time2):
Filter for time 2 denominator (denominator_constraint_x_time2):
Filter for time 1 numerator (numerator_constraint_y_time1:
Filter for time 1 denominator (denominator_constraint_x_time1):



<u>Output</u>
RATIO_Y_X_TIME2: 698.3
RATIO_YPRIME_XPRIME_TIME1: 693.9
DIFFERENCE_RATIOS: 4.3
P_VALUE_TWO_TAILED_TEST: 0.4179

Difference Tester Version 1.0.00

https://apps.fs.usda.gov/Evalidator/diftesterPostRatio.jsp

Difference tester per acre

CREATED_DATE	2019-03-11 13:54:06.0
SCHEMA	FS_FIADB
COMPARISON	-- Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees per acre, on forest land (-- 0004)
ACROSS_EVAL_GROUPS	262017
NUMERATOR_CONSTRAINT_Y_TIME2	null
DENOMINATOR_CONSTRAINT_X_TIME2	null
NUMERATOR_CONSTRAINT_Y_TIME1	null
DENOMINATOR_CONSTRAINT_X_TIME1	null
RATIO_Y_X_TIME2	698.2751
VARIANCE_RATIO_Y_X_TIME2	92.4349
RATIO_Y_X_SE_PERCENT_TIME2	1.3769
RATIO_YPRIME_XPRIME_TIME1	693.9473
VARIANCERATIOYPRIMEXPRIME_T1	89.0786
RATIOYPRIMEXPRIMESEPERCENT_T1	1.3601
DIFFERENCE_RATIOS	4.3280
COVARIANCE_OF_RATIOS	76.5168
STD_ERROR_DIFFERENCE	5.3367
DIFFERENCE_TEST	P-value is greater than critical value of 1 standard error
Z_SCORE	0.8110
P_VALUE_TWO_TAILED_TEST	0.4179
ESTIMATE_Y_TIME2	14,136,284,087.8152
NON_ZERO_PLOTS_Y_TIME2	3731
VARIANCE_Y_TIME2	41,802,417,138,580,536.0000
ESTIMATE_X_TIME2	20,244,576.9594
NON_ZERO_PLOTS_X_TIME2	3788
VARIANCE_X_TIME2	14,433,500,070.1149
ESTIMATE_YPRIME_TIME1	13,947,581,518.8107
NON_ZERO_PLOTS_YPRIME_TIME1	3672
VARIANCE_YPRIME_TIME1	38,692,086,728,107,768.0000
ESTIMATE_XPRIME_TIME1	20,098,907.3707
NON_ZERO_PLOTS_XPRIME_TIME1	3726
VARIANCE_XPRIME_TIME1	14,204,152,071.7326
TOTAL_PLOTS	6050
TOTAL_POPULATION_ACRES	37,385,028.4000

Compare number live trees on forest land between time1 and time 2

MI 2017 inventory

Filters default to attribute description which is number of live trees per acre on forest land

Number of live trees per acre on forest land for time 2

Number of live trees per acre on forest land for time 1

Difference in number of live trees per acre from time 1 to time 2 for the MI 2017 inventory

p-value is greater than 0.3173 (1 standard error) not indicating a significant difference at 68% confidence interval

Identify the inventory years for time 1 and time 2

Select to show area and number of plots by time 1 (previous inventory years) and time 2 (current inventory years) for the change sample of the MI 2017 inventory

RESTful Web Service Call

This RESTful Web Service call can be used to generate estimates directly from browser address line

https://apps.fs.usda.gov/Evalidator/rest/Evalidator/diftestPerAcre?comparison_type=-- temporal_tree_per_acre&attribute_nbr=--0004&schema=FS_FIADB&eval_grp_as_stateyear=262017&numerator_constraint_y_time2=&denominator_constraint_x_time2=&numerator_constraint_y_time1=&denominator_constraint_x_time1=

Web citation: Pugh, S.A.; Westfall, J.A. Mon Mar 11 18:54:14 GMT 2019. Difference Test Per Acre web-application Version 1.0.0 St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. [Available only on internet: https://apps.fs.usda.gov/Evalidator/rest/Evalidator/diftestPerAcre?]

Reference: Westfall, James A.; Pugh, Scott A.; Coulston, John W. 2013. Conducting tests for statistically significant differences using forest inventory data. Res. Pap. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 10 p.?https://doi.org/10.2737/NRS-RP-22.

Partial output from choosing "Identify the inventory years for time 1 and time 2"

Numerator attribute number and description: 0126 Area change - sampled at both inventories by remeasured plots FIADEF as the forest land definition.
Statecd/EVALID(s):
Michigan 262017
Page variable=None (based on values from the Current inventory).
Row variable=Inventory year (based on values from the Previous inventory). — Time 1
Column variable=Inventory year (based on values from the Current inventory). — Time 2
Filtering clause(s):
... — Output removed from this example for brevity

Number of non-zero plots in estimate:

Note: total number of plots in selected evaluations=6050

	Inventory year							
Inventory year	**Total**	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**
Total	6,048	909	930	902	797	1,033	1,290	187
2011	1,091	909	182	-	-	-	-	-
2010	1,308	-	748	560	-	-	-	-
2009	1,139	-	-	342	797	-	-	-
2008	1,033	-	-	-	-	1,033	-	-
2007	1,290	-	-	-	-	-	1,290	-
2006	187	-	-	-	-	-	-	187

Example 2

Compare number of live sawtimber-size red pine trees, in trees per acre, on red pine (field call forest type, c.fldtypcd) timberland plantations (c.stdorgcd) over time in Michigan 2017. The tool inherently constrains the query to forest land, according to the description, but extra constraints for timberland are required. The timberland is not reserved (c.reservcd = 0) and productive (c.siteclcd in [1,2,3,4,5,6]) forest land (c.cond_status_cd = 1).

<u>Input</u>
Comparison Attribute:
-- Number of live trees (at least 1 inch d.b.h./d.r.c.), in trees per acre, on forest land

Evaluation Group:
262017 MICHIGAN 2017: ALL AREA, CURRENT AREA, CURRENT VOLUME, AREA CHANGE, GROWTH, REMOVALS, MORTALITY, DWM, REGENERATION

Filter for time 2 numerator (numerator_constraint_y_time2):
and c.stdorgcd = 1 and c.fldtypcd = 102 and c.reservcd = 0 and c.siteclcd in (1, 2, 3, 4, 5, 6) and t.spcd = 125 and t.dia >= 9
Filter for time 2 denominator (denominator_constraint_x_time2):
and c.stdorgcd = 1 and c.fldtypcd = 102 and c.reservcd = 0 and c.siteclcd in (1, 2, 3, 4, 5, 6)
Filter for time 1 numerator (numerator_constraint_y_time1):

and c1.stdorgcd = 1 and c1.fldtypcd = 102 and c1.reservcd = 0 and c1.siteclcd in (1, 2, 3, 4, 5, 6) and t1.spcd = 125 and t1.dia >= 9
Filter for time 1 denominator (denominator_constraint_x_time1):
and c1.stdorgcd = 1 and c1.fldtypcd = 102 and c1.reservcd = 0 and c1.siteclcd in (1, 2, 3, 4, 5, 6)

Output
RATIO_Y_X_TIME2: 91.2
RATIO_YPRIME_XPRIME_TIME1: 81.4
DIFFERENCE_RATIOS: 9.7
P_VALUE_TWO_TAILED_TEST: 0.0011

Literature Cited

Bechtold, W.A.; Patterson, P.L., eds. 2005. **The enhanced Forest Inventory and Analysis program—national sampling design and estimation procedures.** Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 85 p. https://doi.org/10.2737/srs-gtr-80.

Burrill, Elizabeth A.; Wilson, Andrea M.; Turner, Jeffery A.; Pugh, Scott A.; Menlove, James; Christiansen, Glenn; Conkling, Barbara L.; David, Winnie. 2018. The Forest Inventory and Analysis Database: database description and user guide version 8.0 for Phase 2. U.S. Department of Agriculture, Forest Service. 946 p. [Online]. Available at web address: http://www.fia.fs.fed.us/library/database-documentation/.

Husch, B.; Miller, C.I.; Beers, T.W. 1982. Forest mensuration. New York, NY: John Wiley & Sons, Inc. 402 p.

Pugh, Scott A.; Turner, Jeffery A.; Burrill, Elizabeth A.; David, Winnie. 2018. The Forest Inventory and Analysis Database: population estimation user guide (Edition: November, 2018). U.S. Department of Agriculture, Forest Service. p. [Online]. Available at web address: http://www.fia.fs.fed.us/library/database-documentation.

Westfall, J.A.; Pugh, S.A.; Coulston, J.W. 2013. **Conducting tests for statistically significant differences using forest inventory data.** Res. Pap. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 10 p. https://doi.org/10.2737/nrs-rp-22.

Zheng, B. 2004. Poverty comparisons with dependent samples. Journal of Applied Econometrics 19:419-428.

Appendices

Appendix 1. Considerations

Change Sample versus Current Sample

Since the change sample is used, estimates usually differ from the traditional estimates of current acreage, volume and number of trees. Change sample sets (measured at time 1 and time 2) usually have less plots than current sample sets (measured at time 2) resulting in different weights per plot and different population estimates.

Constraints

In Difference Tester: Totals, all comparisons, except those using the "-- Area of sampled land and water, in acres" attribute, are inherently constrained to forest land as indicated in their descriptions. This built-in constraint ensures that the time 1 estimate is from observations on forest land at time 1 and at least on sampled area at time 2. The time 2 estimate is from observations on forest land at time 2 and at least on sampled area at time 1. Additional constraints can be applied in the filters section.

"-- Area of sampled land and water, in acres" does not include areas of nonsampled but includes all other condition status types unless the user provides a further restriction. The user must explicitly add a constraint filtering to forest land if that is the condition class of interest (e.g., "and c.cond_status_cd = 1" for time 2 and "and c1.cond_status_cd = 1" for time 1).

In Difference Tester: Ratios, comparisons are constrained to forest land as indicated by their descriptions. The built-in constraint ensures that the time 1 estimate is from observations on forest land at time 1 (numerator and denominator) and at least on sampled area at time 2 (numerator and denominator). The time 2 estimate is from observations on forest land at time 2 (numerator and denominator) and at least on sampled area at time 1 (numerator and denominator). Again, additional constraints can be applied in the filters section.

Statistical Tests

Difference Tester accounts for covariance and partial covariance (i.e., partial dependence) between sample sets over time. Difference Tester uses parametric statistics (see Bechtold and Patterson 2005) which are based upon specific assumptions such as the normal distribution of data and equal variances between sample sets.

A covariance correction derived from Zheng (2004) is applied when there is partial dependence as follows:

final covariance = uncorrected covariance * ((# plots in common between time 1 and time 2 samples/# plots in time 2 sample)*(# plots in common between time 1 and time 2 samples/# plots in time 1 sample)).

The # plots in the correction includes all plots from estimation units (see Bechtold and Patterson 2005 and Burrill et al. 2018) where there is at least one nonzero observation for a given user specified constraint.

Scenarios presented in Examples are intended to be a quick look at a few possible comparisons. Normally, a user tests at the 95% confidence level or an alpha (α) level of 0.05. At the 95% confidence level, a statistically significant difference is identified when the p-value is less than 0.05 for a two-tailed test. In a two-tailed test, a significant difference can be positive or negative. Difference Tester outputs a

p-value for a two-tailed test. Divide the p-value in Difference Tester by 2 for a one-tailed test (e.g., test likelihood that the difference is greater than 0). Using the 68% confidence level ($\alpha = 0.32$) to identify significance is not advised. Usually there is ample power to identify differences, even at the 95% confidence level.

When performing multiple tests in one analysis, it is recommended that the critical α level be adjusted to limit the number false positive differences. The Bonferroni correction (adjusted $\alpha = \alpha$ /number of tests) is a simple adjustment method but there are other more powerful methods.

Difference Tester calculates a p-value indicating the likelihood a difference is 0 but one can test the likelihood that a difference is greater or less than any specified amount using a general formula to calculate a Z-score and identify a corresponding p-value from a standard normal distribution table or formula. The Z-score calculation uses the calculated difference estimate (e.g., totals difference is DIFFERENCE_X_Y) and the standard error difference (STD_ERROR_DIFFERENCE) from the Difference Tester output. Any specified difference of interest completes the formula. By default Difference Tester uses 0 as the difference of interest.

Formula for Z-score using total estimates as follows:
Z-score = (DIFFERENCE_X_Y– difference of interest) / STD_ERROR_DIFFERENCE

Difference Tester identifies "statistically significant differences" with p-values. P-values are most often used to communicate findings in peer-reviewed journals.

A difference identified as statistically significant may be inconsequential, nonsensible and/or wrong. Use all available knowledge when assessing output from these scripts. Results of analyses can be misleading especially when parametric assumptions are violated. In general, it is not wise to trust any results based on small sample sizes (e.g., under 50 observations per sample set) without thorough investigation.

Appendix 2. Difference Tester: Totals – Output Definitions

Created date
The system identified date and time of execution.

SCHEMA
Database system with the FIA data.

Comparison
Description of attribute compared.

ACROSS_EVAL_GROUPS
Evaluation groups (separated by commas) passed in by user. Comparisons are made collectively across all specified groups. Nonsensible output results occur when more than one evaluation group is passed in per state.

CONSTRAINT_X_TIME2
Filter or restriction passed in by user for time 2 sample set. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_X_TIME2 (see Example 4).

CONSTRAINT_Y_TIME1
Filter or restriction passed in by user for time 1 sample set. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_Y_TIME1 (see Example 4).

ESTIMATE_X_TIME2
Estimate for time 2 with plots meeting constraints specified by CONSTRAINT_X_TIME2. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_X_TIME2 (see Example 4).

ESTIMATE_Y_TIME1
Estimate for time 1 with plots meeting constraints specified by CONSTRAINT_Y_TIME1. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_Y_TIME1 (see Example 4).

DIFFERENCE_X_Y
Difference of estimates (ESTIMATE_X_TIME2 – ESTIMATE_Y_TIME1).

DIFFERENCE_TEST
Is the observed difference significantly different from 0 at 1, 2, or 3 standard errors? Possible output includes the following:
Standard error of difference is 0
P-value is less than critical value of 3 standard errors associated with 99% confidence level
P-value is less than critical value of 2 standard errors associated with 95% confidence level
P-value is less than critical value of 1 standard error associated with 68% confidence level
P-value is greater than critical value of 1 standard error

STD_ERROR_DIFFERENCE
Standard error of the difference between the estimates. In other words, the square root of the variance of the difference calculated as square root ((variance_x_time2 + variance_y_time1) -

(2*covariance_xy_final)). Uses the final covariance defined here as covariance_xy_final. Covariance is corrected if there is partial dependence.

Z_SCORE
Standard normal distribution value calculated as ((difference_x_y)-0)/std_error_difference).
Used to determine probability that a more extreme difference would be observed if the difference between estimates is actually 0, i.e., used to find a p-value from a standard normal distribution table.

P_VALUE_TWO_TAILED_TEST
Probability that the observed difference, either + or - (two-tailed test), between estimates is actually O. Divide this p-value by 2 for one-tailed test.

NON_ZERO_PLOTS_X_TIME2
Number of plots from time 2 with nonzero observations constrained by CONSTRAINT_X_TIME2. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_X_TIME2 (see Example 4).

NON_ZERO_PLOTS_Y_TIME1
Number of plots from time 1 with nonzero observations constrained by CONSTRAINT_Y_TIME1. There is an exception for the "-- Area of sampled land and water, in acres" attribute which can use time 1 and or time 2 specified constraints in CONSTRAINT_Y_TIME1 (see Example 4).

VARIANCE_X_TIME2
Variance associated with ESTIMATE_X_TIME2.

VARIANCE_Y_TIME1
Variance associated with ESTIMATE_Y_TIME1.

COVARIANCE_XY_FINAL
Final covariance associated with ESTIMATE_X_TIME2 and ESTIMATE_Y_TIME1. This is the final covariance calculation with COV_CORRECTION applied when there is partial dependence.

COV_CORRECTION
Correction applied to the initial covariance estimate when there is partial dependence.

TOTAL_PLOTS
Total number of plots sampled for all evaluation groups specified, not restricted to plots in estimation units with at least one nonzero observation. This includes all plots in the change sample. This includes plots that may be partially nonsampled. Estimates using these plots use adjustment factors on sampled conditions to compensate for nonsampled conditions which are excluded from estimates.

TOTAL_POPULATION_ACRES
Total acreage for all sampled land and water from the change sample of the specified evaluation groups.

Appendix 3. Difference Tester: Ratios – Output Definitions

CREATED_DATE
The system identified date and time of execution.

SCHEMA
Database system with the FIA data.

COMPARISON
Description of attribute compared.

ACROSS_EVAL_GROUPS
Evaluation groups (separated by commas) passed in by user. Comparisons are made collectively across all specified groups. Nonsensible output results occur when more than one evaluation group is passed in per state.

NUMERATOR_CONSTRAINT_Y_TIME2
Filter or restriction passed in by user for numerator of RATIO_Y_X_TIME2.

DENOMINATOR_CONSTRAINT_X_TIME2
Filter or restriction passed in by user for denominator of RATIO_Y_X_TIME2.

NUMERATOR_CONSTRAINT_Y_TIME1
Filter or restriction passed in by user for numerator of RATIO_YPRIME_XPRIME_TIME1.

DENOMINATOR_CONSTRAINT_X_TIME1
Filter or restriction passed in by user for denominator of RATIO_YPRIME_XPRIME_TIME1.

RATIO_Y_X_TIME2
Ratio estimate for time 2.

VARIANCE_RATIO_Y_X_TIME2
Variance of RATIO_Y_X_TIME2. Covariance is corrected for partial dependence. All samples (plots with zero and nonzero observations) in any estimation unit that has at least one nonzero observation contribute to any correction for partial dependence.

RATIO_Y_X_SE_PERCENT_TIME2
Standard error in percent for RATIO_Y_X_TIME2 or ((square root (VARIANCE_RATIO_Y_X_TIME2) / RATIO_Y_X_TIME2)*100.

RATIO_YPRIME_XPRIME_TIME1
Ratio estimate for time 1.

VARIANCERATIOYPRIMEXPRIME_T1
Variance of RATIO_YPRIME_XPRIME_TIME1. Covariance is corrected for partial dependence. All samples (plots with zero and nonzero observations) in any estimation unit that has at least one nonzero observation contribute to any correction for partial dependence.

RATIOYPRIMEXPRIMESEPERCENT_T1
Standard error in percent for RATIO_YPRIME_XPRIME_TIME1 or ((square root (VARIANCERATIOYPRIMEXPRIME_T1) / RATIO_YPRIME_XPRIME_TIME1)*100.

DIFFERENCE_RATIOS
Difference between ratios, RATIO_Y_X_TIME2 - RATIO_YPRIME_XPRIME_TIME1.

COVARIANCE_OF_RATIOS
Covariance of ratios RATIO_Y_X_TIME2 and RATIO_YPRIME_XPRIME_TIME1.

STANDARD_ERROR_DIFFERENCE
Standard error of the difference between ratios or square root of the variance of the difference between ratios or square root ((VARIANCE_RATIO_Y_X_TIME2 + VARIANCERATIOYPRIMEXPRIME_T1) - (2 * COVARIANCE_OF_RATIOS)).

DIFFERENCE_TEST
Is the observed difference significantly different from 0 at 1, 2, or 3 standard errors? Possible output includes the following:
Standard error of difference is 0
P-value is less than critical value of 3 standard errors associated with 99% confidence level
P-value is less than critical value of 2 standard errors associated with 95% confidence level
P-value is less than critical value of 1 standard error associated with 68% confidence level
P-value is greater than critical value of 1 standard error

Z_SCORE
Standard normal distribution value calculated as ((DIFFERENCE_RATIOS-0)/ STANDARD_ERROR_DIFFERENCE). Used to determine probability that a more extreme difference would be observed if the difference between ratio estimates is actually 0; i.e., used to find a p-value from a standard normal distribution table.

P_VALUE_TWO_TAILED_TEST
Probability that the observed difference, either + or - (two-tailed test), between estimates is actually O. Divide this p-value by 2 for one-tailed test.

ESTIMATE_Y_TIME2
Estimate for numerator of RATIO_Y_X_TIME2.

NON_ZERO_PLOTS_Y_TIME2
Number of plots from time 2 with nonzero observations constrained by NUMERATOR_CONSTRAINT_Y_TIME2.

VARIANCE_Y_TIME2
Variance of ESTIMATE_Y_TIME2.

ESTIMATE_X_TIME2
Estimate for denominator of RATIO_Y_X_TIME2.

NON_ZERO_PLOTS_X_TIME2
Number of plots from time 2 with nonzero observations constrained by DENOMINATOR_CONSTRAINT_X_TIME2.

VARIANCE_X_TIME2
Variance of ESTIMATE_X_TIME2.

ESTIMATE_YPRIME_TIME1
Estimate for numerator of RATIO_YPRIME_XPRIME_TIME1.

NON_ZERO_PLOTS_YPRIME_TIME1
Number of plots from time 2 with nonzero observations constrained by NUMERATOR_CONSTRAINT_Y_TIME1.

VARIANCE_YPRIME_TIME1
Variance of ESTIMATE_YPRIME_TIME1.

ESTIMATE_XPRIME_TIME1
Estimate for denominator of RATIO_YPRIME_XPRIME_TIME1.

NON_ZERO_PLOTS_XPRIME_TIME1
Number of plots from time 2 with nonzero observations constrained by DENOMINATOR_CONSTRAINT_X_TIME1.

VARIANCE_XPRIME_TIME1
Variance of ESTIMATE_XPRIME_TIME1.

TOTAL_PLOTS
Total number of plots sampled for all evaluation groups specified, not restricted to plots in estimation units with at least one nonzero observation. This includes all plots of the change sample. This includes plots that may be partially nonsampled. Estimates using these plots use adjustment factors on sampled conditions to compensate for nonsampled conditions which are excluded from estimates.

TOTAL_POPULATION_ACRES
Total acreage for all sampled land and water from the change sample of the specified evaluation groups.